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The Vegetation of the Mount Livermore Area in Texas

L. C. Hinckley

Introduction

The Mount Livermore area is geologically a part of the Front Range of the Western Cordilleras, a system which reaches its easternmost extension in the United States within that section of western Texas known as the Trans-Pecos Region. Livermore itself is the highest point in the Sawtooth Range of the Davis Mountains, a small system originating in deformational movements during late Cretaceous time. Succeeding periods of erosion, lava flows, other deformational movements, and the severe erosion of recent time have formed a lava canyon region covering several hundred square miles.

Baker and Bowman (1917) describe the Sawtooth Range as a broad, low anticline of intrusive porphyritic syenite. The major axis of the range has a general northwest-southeast direction, Mount Livermore occupying almost a middle position. The whole range probably marks a line of fissure eruptions of which the cliffs of the highest peak are typical examples (Fig. 1).

Previous Botanical Research

Early botanical work in the Livermore area was concerned chiefly with collections and descriptive writings. Sponsored by Gray (1850-52), Wright made two collecting trips through the Davis Mountains, accompanying a military wagon train from San Antonio to El Paso in 1849 and as a member of the Graham Boundary Survey on its return from the West in 1852 (Wooton, 1906). Two other members of the U. S.-Mexican Boundary Expedition, Bigelow and Schott, secured specimens in Limpia Canyon of the Davis Mountains, according to descriptions of the plants of the expedition made by Torrey (1858) and Engelmann (1859). Havard (1885) and Neally (1888) included descriptions of some of the plants of the Davis Mountains in their accounts of the vegetation of the Southwest, and Coulter (1891-94) compiled all of these early descriptions in a manual of the flora of western Texas.

Investigations made since 1900 have dealt more with the ecological phase of botany. Bray (1901, 1906), in the first wholly ecological treatise of the vegetation of the Southwest, discussed climatic and edaphic factors and described the region as the meeting ground of several life zones. Dr. M. S. Young left unpublished notes in the botany department of the University of Texas dealing with an ecologic and taxonomic study of vegetation of the Livermore area in 1914 and 1918. In the only published article wholly concerned with the vegetation of the Davis Mountains, Palmer (1929) inferred that the colonies of ligneous plants are relics of a once more or less continuous flora which covered most of western North America.

Present Work

The present work has attempted an intensive survey of the vegetation of Mount Livermore and its immediate vicinity. The field work was begun in

September, 1934, and was continued at intervals until October, 1939. Most of the work was done in summer and fall; but occasional trips were made during spring, early summer, and winter months.

Precipitation

The amount of precipitation for the Mount Livermore area was estimated from a study of the records kept at Fort Davis, which is about twenty-five miles southeast of Mount Livermore, and those of McDonald Observatory on Mount Locke 9.5 miles almost east of the higher peak. The Fort Davis records, kept intermittently since 1855, show an average annual precipitation of 16.48 inches (Table 1). The five-year records of McDonald Observatory show an average about $3\frac{1}{2}$ inches greater than that at Fort Davis, or about twenty inches.

Since the higher average is probably due in part to the difference in elevation, 6790 feet on Mount Locke as compared to about 4800 feet at Fort Davis, it seems safe to assume that the annual average on Mount Livermore is at least twenty-five inches. Observations also tend to prove that the precipitation is greater on the higher peak, elevation 8382 feet, for clouds often are seen to accumulate over its summit when skies elsewhere are cloudless.

The monthly averages for the period of the records indicate that about one-half of the precipitation occurs during the months of July, August, and September (Table 1); and about three-fourths occurs during the months from May through September. It would seem then that the growing season is limited to about six months.

Temperature

Though the Davis Mountains lie between the thirtieth and the thirty-first parallels, the mean temperatures are comparatively low. The mean annual temperature at Fort Davis for the twenty-nine years covered by the records is 60.8° (Table 2). The five-year record of McDonald Observatory shows the mean annual temperature to be 56.9° , about four degrees lower than that of Fort Davis. By comparing the mean annual temperatures of Fort Davis and Mount Locke, one may assume that the mean annual temperature of Mount Livermore is about fifty degrees.

Frost data for Fort Davis and Mount Locke indicate an average length of time between killing frosts of about 210 days for the former and 200 days for the latter from the latest freeze in spring to the earliest freeze in autumn. By inference again the average length of time between killing frosts from spring to fall on the upper slopes of Mount Livermore is somewhat less than 200 days, probably about six months. It would seem then that low temperatures as well as seasonal rainfall might limit the growing season to about six months. Both factors are unpredictable in this area.

Topography

The Mount Livermore area is a region of rough, broken terrain consisting of an east-west ridge with the peak as the apex and canyons originating on all sides of the oblong summit (Figs. 1 & 2). On the north and northwest are

the various branches of Madera Canyon, one that will be called the middle branch having its origin at the north base of the summit. On the opposite side of the summit is the head of Pine Canyon, which occupies most of the upper part of the southern slope of the mountain. A deep gorge, the source of Goat Canyon, lies on the west slope; and the sources of Limpia and Merrill Canyons are found in the ridges about one-half mile east of the summit.

Structure of the Vegetation

Since the Davis Mountains are a part of the Rocky Mountain system, one naturally expects the vegetation to resemble that of the Cordilleras. On Mount Livermore the presence of the quaking aspen (*Populus tremuloides* Michx.) and the limber pine (*Pinus flexilis* James) indicates a tendency toward the

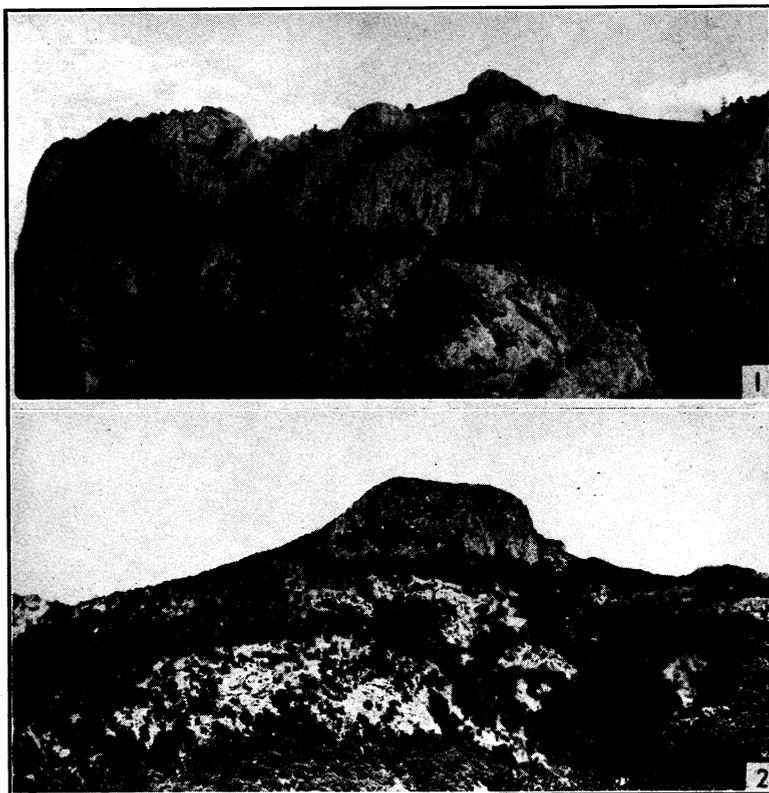


Fig. 1. Cliffs of intrusive material, the summit of Mount Livermore in background. The sources of Goat Canyon and the west branch of Madera Canyon are gorges in the right center of picture. North facing cliffs at the left.

Fig. 2. The summit of Mount Livermore showing part of the south slope. In the foreground is a little forest of gray oak in the head of Pine Canyon. Gambel's oak forms thickets at the base of the summit.

Petran subalpine forest, a formation extending along the ranges of the Rocky Mountains from Canada to southern New Mexico. The Petran montane forest, found in the Cordilleras from Canada to Mexico, is definitely represented on several peaks of the Livermore area by the western yellow pine (*Pinus ponderosa* Dougl.). Another dominant of this formation, the Douglas fir (*Pseudotsuga taxifolia* (Poir.) Rehder), present in the Chisos Mountains more than one hundred miles to the southeast, is not found in the Davis Mountains. The characteristic formation of most of the area is woodland represented by various combinations of *Pinus-Quercus-Juniperus* groupings.

The summit of Mount Livermore is so bare of vegetation that it was early designated as Baldy Peak and is still so named on geological survey maps. (Fig. 2). This elongated mound of rock, some forty to seventy-five feet wide and two hundred or more feet long at the base, is easily scaled on the western end; and, once at the top, one finds only scattered scrubby shrubs and a scanty growth of herbs and grasses. Though no particular plant association is represented in this restricted area, a list of the plants collected on the summit shows some variety.

Shrubs

Bouvardia ternifolia (Cav.) Schlecht.

Echinocereus chloranthus (Engelm.)

Rumpler

Fendlera rupicola Gray

Holodiscus dumosus (Nutt.) Heller

Opuntia strigil Engelm.

Philadelphus argyrocalyx Wooton

Ptelea tomentosa Raf.

Forbs

Arenaria fendleri Gray

Artemisia mexicana Willd.

Brickellia brachyphylla Gray

Chenopodium incisum Poir.

Chrysopsis hispida (Hook.) Nutt.

Commelina dianthifolia Delile

Eriogonum jamesii Benth.

Galium wrightii Gray

Gnaphalium decurrens Ives

Hieracium wrightii (Gray) Robins.
& Greenm.

Mirabilis comata (Small) Standl.

Phacelia congesta Hook.

Salvia arizonica Gray

Silene laciniata Cav.

Solanum fendleri Gray

Solanum nigrum L.

Thelypodium linearifolium (Gray) Wats.

Viguiera cordifolia Gray

Grasses

Agropyron arizonicum Scribn. & Smith

Bouteloua hirsuta Lag.

Bromus latiglumis (Shear) Hitchc.

Lycurus phleoides H.B.K.

Muhlenbergia glauca (Nees) Mez

Muhlenbergia polycaulis Scribn.

Stipa tenuissima Trin.

North of the summit the mountain descends abruptly by a series of broken ledges from an altitude of more than 8000 feet to less than 7500 feet. In this area, the source of the middle branch of Madera Canyon, quite characteristic vegetation is found. At the bases of the ledges and bordering the talus slopes there are thickets of Gambel's oak (*Quercus gambelii* Nutt.) and bush rock-spirea (*Holodiscus dumosus* (Nutt.) Heller), while the steep slopes between the ledges usually are covered with mountain snowberry (*Symphoricarpos oreophilus* Gray). One less sloping area about one hundred yards northeast of the summit has an open grove of medium-sized western yellow pine. Near the crest of the ridge running eastward from the base of the summit is a small

grove of Gambel's oak (Fig. 3). Only a few feet over the crest on the south slope the gray oak (*Quercus grisea* Liebm.) and the alligator juniper (*Juniperus pachyphloea* Torr.) are found.

Shaded spots in the area north of the summit have a second layer of meadow rue (*Thalictrum wrightii* Gray), Arizona sage (*Salvia arizonica* Gray), and others, in various combinations of all or two or more. In the same areas, but more scattered, are found wild geranium (*Geranium atropurpureum* Heller), bedstraw (*Galium vaillantii* DC.), and giant hyssop (*Agastache verticillata* Woot. & Standl.). In less shaded spots sagebrush (*Artemisia dracunculoides* Pursh and *A. mexicana* Willd.) and gromwell (*Lithospermum multiflorum* Torr.) are prevalent. Open spots bordering the tops of the ledges are occupied by the small-jointed prickly pear (*Opuntia strigil* Engelm.), sandwort (*Arenaria fendleri* Gray), or shrubby buckwheat (*Eriogonum jamesii* Benth.); and clumps of golden aster (*Chrysopsis hispida* (Hook.) Nutt.) cling conspicuously on their walls and edges.

Below the lowermost ledge of the area and in the bed of the canyon is a peculiar plant formation consisting of quaking aspens and Gambel's oak. A large number of the aspens are small, slender specimens that resemble the straight trees of the Rocky Mountains. Mixed with the aspens are numerous specimens of the oak, almost as tall and straight as the aspens themselves. The whole plant group forms a grove of trees so thick as to hinder one's progress through it.

Just east of the aspen and oak grove a consociation of limber pine extends up a narrow tributary and a short distance down the united middle branch of Madera Canyon. Some of the trees in this small forest are seventy feet high and two feet in diameter. Fire scars occur on a few of the boles, a condition

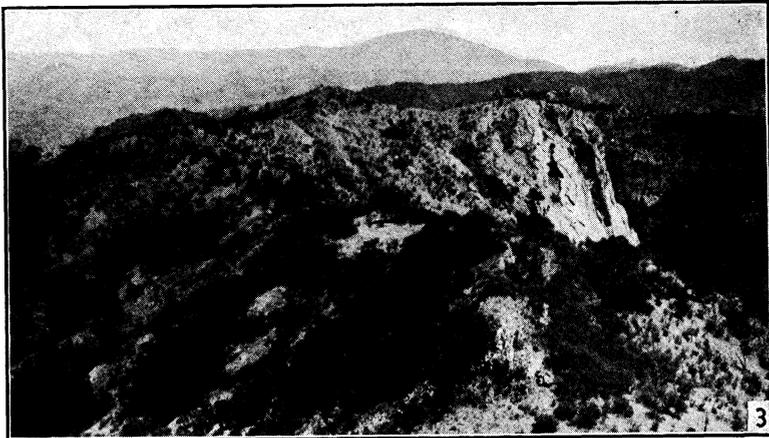


Fig. 3. Crest of ridge running eastward from base of summit of Mount Livermore. On the left is the slope leading into the middle branch of Madera Canyon and on the right is Pine Canyon. Gambel's oak on the left and gray oak on the right of the crest.

that indicates a more profuse growth of vegetation at some previous times. The writer saw a fire in the Davis Mountains, probably on Mount Livermore, from a distance of thirty miles in the spring of 1928.

In the partially open spaces among the pines are thickets of bush rock-spirea and mountain snowberry. In the shaded areas there is a layer of Arizona sage and Junegrass (*Koeleria cristata* (L.) Pers.), while in the late summer and fall various species of composites are conspicuous (*Brickellia fendleri* Gray and *Eupatorium fendleri* Gray).

A list of the plants collected on the slope north of the summit down to elevation about 7400 feet is given below. This area covers the source of the middle branch of Madera Canyon.

Dominants

Pinus flexilis James

Quercus gambelii Nutt.

Pinus ponderosa Dougl.

Subdominants

Holodiscus dumosus (Nutt.) Heller

Symphoricarpos oreophilus Gray

Populus tremuloides Michx.

Other Plants

Trees

Pinus edulis Engelm.

Prunus virens (Woot. & Standl.) Standl.

Shrubs

Cercocarpus breviflorus Gray

Philadelphus argyocalyx Wooton

Echinocereus chloranthus (Engelm.)

Ptelea tomentosa Raf.

Rumpler

Opuntia strigil Engelm.

Rhamnus betulaeifolia Greene

Salix lasiolepis Benth.

Lianas

Vitis arizonica Engelm.

Parthenocissus vitacea (Kner) Hitchc.

Forbs

Achillea lanulosa Nutt.

Chrysopsis hispida (Hook.) Nutt.

Agastache micrantha (Gray) Woot. & Standl.

Commelina dianthifolia Delile

Agastache vericillata Woot. & Standl.

Cyperus fendlerianus Boeckl.

Allium neomexicanum Rydb.

Draba gilgiana Woot. & Standl.

Amaranthus powellii Wats.

Dicranocarpus parviflorus Gray

Antennaria peramoena Greene

Erigeron flagellaris Gray

Anthericum torreyi Baker

Eriogonum jamesii Benth.

Aquilegia chrysantha Gray

Erysimum asperinum (Greene) Rydb.

Aralia racemosa L.

Eupatorium fendleri Gray

Arenaria confusa Rydb.

Eupatorium herbaceum (Gray) Greene

Arenaria fendleri Gray

Eupatorium urticaefolium Reichard

Artemisia dracunculoides Pursh

Euphorbia bifurcata Engelm.

Artemisia mexicana Willd.

Euphorbia chamaesula Boiss.

Aster oblongifolius var. *rigidulus* Gray

Galium vaillantii DC.

Astragalus yaquianus Wats.

Gentiana bigelovii Gray

Brickellia brachyphylla Gray

Geranium atropurpureum Heller

Brickellia fendleri Gray

Heuchera rubescens Torr.

Brickellia grandiflora (Hook.) Nutt.

Laphamia quinqueflora Steyermark

Brickellia reniformis Gray

Lappula pinetorum Greene

Campanula rotundifolia L.

Lathyrus graminifolius (Wats.) White

Chenopodium fremontii Wats.

Linum lewisii Pursh

Chenopodium incisum Poir.

Lithospermum multiflorum Torr.

Mirabilis comata (Small) Standl.

<i>Monarda austromontana</i> Epling	<i>Sicyos parviflorus</i> Willd.
<i>Monarda menthaefolia</i> Graham	<i>Silene laciniata</i> Cav.
<i>Musenopsis texana</i> (Gray) Coult. & Rose	<i>Solidago trinervata</i> Greene
<i>Oxalis amplifolia</i> (Trel.) Kunth	<i>Solidago wrightii</i> Gray
<i>Pentstemon torreyi</i> Benth.	<i>Sophia adenophora</i> Woot. & Standl.
<i>Phacelia congesta</i> Hook.	<i>Stellaria cuspidata</i> Willd.
<i>Pseudocymopterus montanus</i> (Gray) Coult. & Rose	<i>Thalictrum wrightii</i> Gray
<i>Salvia arizonica</i> Gray	<i>Thelypodium linearifolium</i> (Gray) Wats.
<i>Senecio millelobatus</i> Rydb.	<i>Urtica gracilis</i> Ait.
<i>Senecio microdontus</i> (Gray) Heller	<i>Verbesina oreophila</i> Woot. & Standl.

Grasses

<i>Agropyron arizonicum</i> Scribn. & Smith	<i>Echinochloa crusgalli</i> Beauv.
<i>Blepharoneuron tricholepis</i> (Torr.) Nash	<i>Festuca idahoensis</i> Elmer
<i>Bromus ciliatus</i> L.	<i>Koeleria cristata</i> (L.) Pers.
<i>Bromus carinatus</i> Hook. & Arn.	<i>Lycurus phleoides</i> H.B.K.
<i>Bouteloua gracilis</i> (H.B.K.) Lag.	<i>Muhlenbergia montana</i> (Nutt.) Hitchc.
<i>Bouteloua hirsuta</i> Lag.	

Northwest of the area described above there is a high ridge of rock whose southern face lies just across the head of the middle branch of Madera Canyon. The north face of this ridge forms cliffs several hundred feet high, and below these cliffs the mountain slopes rapidly downward to the bed of the west branch of Madera Creek. It is on this slope, about one hundred acres in extent, that the heaviest forest is found.

At the base of the cliffs there is a triangular area of a few acres in extent consisting of talus slopes bare in spots but mostly covered with a thin accumulation of soil that supports some vegetation. Invading from below and along the edges of steeper talus slopes is Gambel's oak. Mixed with the oak and growing at still higher altitudes (about 7700 feet) is a thin grove of aspens, some of the specimens being the largest found in the Davis Mountains. While trees of this species twelve to fifteen inches in diameter would be fifty or sixty feet tall in favorable parts of the Rocky Mountains, these have struggled to reach a height of thirty-five feet.

Above the aspens there are tangles of gooseberry (*Ribes leptanthum* Gray), mountain snowberry, and bush rockspirea. Grapevines (*Vitis arizonica* Engelm.) and Virginia creeper (*Parthenocissus vitacea* (Kner) Hitchc.) clamber thinly over the rocks, and in a crevice at the base of the cliffs is a healthy bed of malefern (*Dryopteris filix-mas* (L.) Schott). Several trees of elderberry (*Sambucus neomexicana* Wooton) are present here, the only representatives of the species in the vicinity of Mount Livermore with the exception of two or three small trees in the upper gorge of Goat Canyon.

Below the triangular area just described is a forest typical of the north facing slopes elsewhere in the Livermore region. Numerous small tributaries of Madera Creek alternate with dry ridges and gravelly slopes. On the dry shoulders and slopes are forests of pinyon pine (*Pinus edulis* Engelm.), alligator juniper and gray oak, these species occurring in greatest abundance in the order given as one descends the slope. On the arroyo banks and the slopes that are less dry the whiteleaf oak (*Quercus hypoleucoides* A. Camus) and the western yellow pine are dominant. The whiteleaf oak usually occurs in

clumps of small trees up to four or five inches in diameter, but often it forms thickets of small shrubs hard to penetrate. The pines for the most part are young growth (Fig. 4), none of the trees having boles more than twelve inches in diameter. Dry years and infection by mistletoe (*Arceuthobium cryptopodum* Engelm.) are taking their toll, but it seems as if the stand is sufficiently thick to maintain this species as a dominant.

A list of the plants collected in the area from the base of the north-facing cliffs, elevation about 7800 feet, to a point almost a mile north where the branches of Madera Canyon unite shows quite a number of ligneous species.

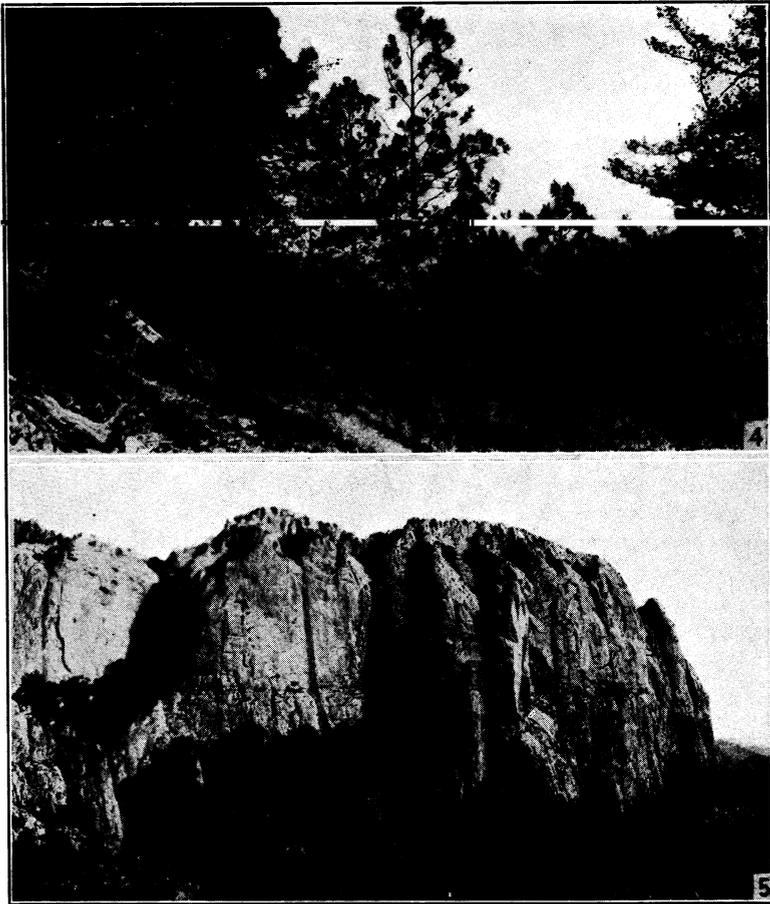


Fig. 4. Western yellow pine on the north slope of Mount Livermore. Groves like this usually are found along the arroyo banks and on somewhat dry rocky slopes.

Fig. 5. West facing cliffs of Mount Livermore. Aspens and western yellow pines form the forest here.

Dominants

<i>Juniperus pachyphloea</i> Torr.	<i>Quercus grisea</i> Liebm.
<i>Pinus edulis</i> Engelm.	<i>Quercus hypoleucoides</i> A. Camus
<i>Pinus ponderosa</i> Dougl.	

Subdominants

<i>Pinus flexilis</i> James	<i>Quercus gambelii</i> Nutt.
<i>Populus tremuloides</i> Michx.	

Other Plants

Trees

<i>Arbutus texana</i> Buckl.	<i>Sambucus neomexicana</i> Wooton
<i>Quercus gravesii</i> Sudw.	

Shrubs

<i>Cercocarpus breviflorus</i> Gray	<i>Ribes leptanthum</i> Gray
<i>Holodiscus dumosus</i> (Nutt.) Heller	<i>Symphoricarpos oreophilus</i> Gray
<i>Ptelea tomentosa</i> Raf.	

Lianas

<i>Parthenocissus vitacea</i> (Knerr) Hitchc.	<i>Vitis arizonica</i> Engelm.
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Forbs

<i>Allium neomexicanum</i> Rydb.	<i>Geranium atropurpureum</i> Heller
<i>Briqellia grandiflora</i> (Hook.) Nutt.	<i>Lithospermum multiflorum</i> Torr.
<i>Briqellia hinckleyi</i> Standl. sp. nov.	<i>Pseudocymopterus montanus</i> (Gray) Coult. & Rose
<i>Campanula rotundifolia</i> L.	<i>Salvia arizonica</i> Gray
<i>Chenopodium incisum</i> Poir.	<i>Senecio millelobatus</i> Rydb.
<i>Erysimum asperrimum</i> (Greene) Rydb.	<i>Silene laciniata</i> Cav.
<i>Galium vaillantii</i> DC.	
<i>Galium wrightii</i> Gray	

Grasses

<i>Bouteloua hirsuta</i> Lag.	<i>Piptochaetium fimbriatum</i> (H.B.K.) Hitchc.
<i>Muhlenbergia emersleyi</i> Vasey	<i>Setaria grisebachii</i> Fourn.

The slope leading southward from the base of the summit has an oak-pinyon association. A very fine grove of gray oak, about two acres in extent, is growing near the western end of the slope in the upper limits of Pine Canyon (Fig. 2). A few low, spreading specimens of the pine are found ranging eastward from the oak grove where the mountain slopes abruptly from more than 8000 feet elevation to about 7500 feet into the canyon. Scraggly specimens of the alligator juniper are scattered over the upper part of the slope, and on its dry shoulders there occur thickets of mountain mahogany (*Cercocarpus breviflorus* Gray). Unshaded areas have a fairly good covering of hairy grama (*Bouteloua hirsuta* Lag.) or wolftail (*Lycurus phleoides* H.B.K.), while otherwise bare spots sustain clumps of the prostrate prickly pear or shrubby wild buckwheat. Noticeable under the more scattered trees, protected by their shade, are the foxtail (*Setaria grisebachii* Fourn.) and the goosefoot (*Chenopodium incisum* Poir.). Other plants most commonly found in the shade are the four-o'clock (*Mirabilis wrightiana* Gray), the nettle (*Urtica gracilis* Ait.), and sagebrush (*Artemisia mexicana* Willd.).

A list of the plants collected on the southern slopes of Mount Livermore

shows some contrast to the vegetation of the north slope. The dominants of the upper northern slope are not present in any great number on the exposed southern slope, and the dominants of the upper southern slope are found at five hundred feet or more lower elevation on the northern slope. Except in the case of the grove of gray oak, the trees on the south slope are rather scattered; but the forests on the north slope are often quite thick.

Dominants

Pinus edulis Engelm.*Quercus grisea* Liebm.

Subdominants

Bouteloua hirsuta Lag.*Cercocarpus breviflorus* Gray

Other Plants

Trees

Juniperus pachyphloea Torr.*Quercus gambelii* Nutt.*Prunus virens* (Woot. & Standl.) Standl.

Shrubs

Adolphia infesta Meisn.*Holodiscus dumosus* (Nutt.) Heller*Bouvardia ternifolia* (Cav.) Schlecht.*Opuntia strigil* Engelm.*Echinocereus chloranthus* (Engelm.)*Ptelea tomentosa* Raf.

Rumpler

Fendlera rupicola Gray*Rhamnus betulaeifolia* Greene*Symphoricarpos oreophilus* Gray

Forbs

Acalypha neomexicana Muell. Arg.*Ipomoea lindheimeri* Gray*Agastache micrantha* (Gray) Woot. & Standl.*Lathyrus graminifolius* (Wats.) White*Amaranthus powellii* Wats.*Linum lewisii* Pursh*Arenaria fendleri* Gray*Lotus rigidus* (Benth.) Greene*Artemisia mexicana* Willd.*Mentzelia aspera* L.*Astragalus yaquianus* Wats.*Mirabilis aggregata* (Ort.) Cav.*Bahia bigelovii* Gray*Mirabilis wrightiana* Gray*Brickellia brachyphylla* Gray*Monarda austromontana* Epling*Castilleja sessiliflora* Pursh*Oxalis amplifolia* (Trel.) Kunth*Chenopodium fremontii* Wats.*Paronychia jamesii* Torr. & Gray*Chenopodium incisum* Poir.*Parosela filiformis* (Gray) Heller*Chrysopsis hispida* (Hook.) Nutt.*Portulaca lanceolata* Engelm.*Commelina dianthifolia* Delile*Relbunium microphyllum* (Gray) Hemsl.*Conyza sophiaefolia* H.B.K.*Salvia arizonica* Gray*Cosmos parviflorus* H.B.K.*Sedum wrightii* Gray*Cyclanthera dissecta* (Torr. & Gray) Arn.*Senecio millelobatus* Rydb.*Cyperus fendlerianus* Boeckl.*Sicyos parviflorus* Willd.*Drymaria fendleri* Wats.*Sisymbrium wrightii* Gray*Eriogonum jamesii* Benth.*Solanum fendleri* Gray*Erysimum asperinum* (Greene) Rydb.*Solanum nigrum* L.*Euphorbia bifurcata* Engelm.*Sophia adenophora* Woot. & Standl.*Froelichia gracilis* (Hook.) Moq.*Talinum chisosense* Mueller*Galinsoga semicalva* (Gray) St. John & White*Talinum parviflorum* Nutt.*Galium vaillantii* DC.*Thalictrum wrightii* Gray*Galium wrightii* Gray*Thelypodium linearifolium* (Gray) Wats.*Geranium atropurpureum* Heller*Thelypodium micranthum* (Gray) Small*Geranium mexicanum* H.B.K.*Urtica gracilis* Ait.*Gnaphalium decurrens* Ives*Verbena neomexicana* (Gray) Small*Hedeoma plicata* Torr.*Verbesina oreophila* Woot. & Standl.*Ipomoea cardiophylla* Gray*Viguiera cordifolia* Gray*Viguiera multiflora* (Nutt.) Blake*Yucca baccata* Torr.

Grasses

Aristida divaricata Humb. & Bonpl.
Blepharoneuron tricholepis (Torr.) Nash
Bouteloua gracilis (H.B.K.) Lag.
Bouteloua hirsuta Lag.
Bromus anomalus var. *lanatipes* (Shear)
 Hitchc.
Bromus latiglumis (Shear) Hitchc.
Bromus marginatus Nees

Festuca idahoensis Elmer
Koeleria cristata (L.) Pers.
Lycurus phleoides H.B.K.
Muhlenbergia depauperata Scribn.
Muhlenbergia glauca (Nees) Mez
Muhlenbergia montana (Nutt.) Hitchc.
Muhlenbergia polycaulis Scribn.
Setaria grisebachii Fourn.

Below 7500 feet elevation Pine Canyon drops abruptly for several hundred feet. Here where the canyon is narrow the most noticeable trees are wild cherries (*Prunus virens* (Woot. & Standl.) Standl.). At 7000 feet and for some distance downward clumps of the whiteleaf oak are found. Thin groves of western yellow pine in the upper half of its course give Pine Canyon its name; but the writer, first entering at its junction with Merrill Canyon three miles south of Mount Livermore, called it "Redoak" Canyon from the numerous trees of Graves' oak (*Quercus gravesii* Sudw.) found in its lower reaches. As Pine Canyon widens to merge with Merrill Canyon, Emory's oak (*Quercus emoryi* Torr.) forms an open forest, which extends both up and down Merrill Canyon from the mouth of the tributary.

Merrill Canyon has its origin in the ridges east of the summit. The ridge extending east from the base of the summit is split into several divisions, and it is about one mile east of the top of the mountain in some of these ridges that this canyon starts in an easterly direction. Forming a gradual curve, it has changed to a southwesterly direction by the time it has united with Pine Canyon.

On the slopes leading down into the source of Merrill Canyon there are numerous alligator junipers, but as the canyon begins to drop abruptly these are replaced by whiteleaf oak. At an altitude of about 6600 feet and continuing down the canyon for more than a mile the reticulate-leaf oak (*Quercus reticulata* Humb. & Bonpl.) forms a forest covering the canyon bed. This is the only canyon in the vicinity of Mount Livermore that has this oak. Below an elevation of about 6200 feet Emory's oak becomes the dominant tree of the canyon.

The upper sources of Limpia Canyon have their origin on the northern slopes of the ridges east of the summit. The two divisions of upper Limpia have vegetation tending toward the Petran subalpine forest, for here are found both the aspen and the limber pine. It was somewhere in this canyon that a government sawmill was built to furnish lumber for old Fort Davis, and at some future date more lumber can be procured from the present stand of western yellow pine and the limber pine found there.

This forest is replaced at an elevation of about 7300 feet by forests and thickets of the whiteleaf oak with frequent specimens of western yellow pine mixed with the oak. Since the general direction of the canyon is eastward for

some two miles, the Pinus- Quercus association consisting of whiteleaf oak and western yellow pine has a greater extent in length here than in any other canyon. At an elevation of about 6100 feet the canyon widens; and Emory's oak is found mixed with the whiteleaf oak, which it finally replaces a little farther downward. It was in this area where whiteleaf oak, Emory's oak, and western yellow pine are in close proximity that the writer helped procure large blocks of the trunks of these trees for exhibiting at the Texas Centennial several years ago. The blocks, almost two feet in diameter, were not the largest that might be found in the area.

Just west of the summit of Mount Livermore a short gentle slope is ended by a series of jagged peaks and precipices cut by a half dozen gorges (Fig. 1). One of these gorges is the source of Goat Canyon; another is the main source of the west branch of Madera Canyon. These two gorges, because of their proximity and similar exposure, have similar vegetation. A few of the typical plants common to both gorges are listed here.

Trees

Pinus ponderosa Dougl. *Quercus gambelii* Nutt.
Prunus virens (Woot. & Standl.) Standl.

Shrubs

Holodiscus dumosus (Nutt.) Heller *Rhamnus betulaeifolia* Greene

Lianas

Parthenocissus vitacea (Knerr) Hitchc. *Vitis arizonica* Engelm.

Forbs

Aquilegia chrysantha Gray *Polemonium hinckleyi* Standl. sp. nov.
Artemisia mexicana Willd. *Silene laciniata* Cav.
Chrysopsis hispida (Hook.) Nutt. *Solanum fendleri* Gray
Erysimum asperrimum (Greene) Rydb. *Thalictrum wrightii* Gray
Euphorbia bifurcata Engelm. *Urtica gracilis* Ait.
Geranium atropurpureum Heller *Verbesina oreophila* Woot. & Standl.
Heuchera rubescens Torr.

At the base of the cliffs from which Goat Canyon gorge emerges the vegetation is almost identical with that below the north-facing cliffs previously described, the conditions of soil, light, temperature, and moisture being quite similar in the two localities. Western yellow pine, Gambel's oak, and aspens form a small forest.

Below this forest at about 7500 feet the canyon is characterized by a thick forest of whiteleaf oak, which about one mile downward merges with Emory's oak. The latter then comprises the entire forest, except for scattered specimens of Grave's oak, for some four miles down the canyon to its junction with Merrill Canyon.

High up in the cliffs forming the southwest face of Mount Livermore (Fig. 5) there is an amphitheater-like pocket. Because it is partially protected from wind and sun, the vegetation in this pocket is less subjected to drying than the south slope in general. An accumulation of humus and only a narrow

gap for water runoff have built up a deeper soil which maintains a high moisture content. Some variety in the list of trees and shrubs may be noted, some of the largest trees in the Davis Mountains being located here.

Trees

Juniperus pachyphloea Torr.

Pinus edulis Engelm.

Pinus flexilis James

Pinus ponderosa Dougl.

Prunus virens (Woot. & Standl.) Standl.

Quercus gambelii Nutt.

Quercus grisea Liebm.

Shrubs

Cercocarpus breviflorus Gray

Ptelea tomentosa Raf.

Symphoricarpos oreophilus Gray

Yucca baccata Torr.

The ridges radiating from the vicinity of Mount Livermore have for the most part a thin cover of woodland climax consisting of pinyon pine, alligator juniper, and gray oak, these species occurring in the order of their ability to withstand xerophytic conditions as one progresses away from the mountain. Some of the south-facing ridges are bare of forests in quite large spots, sacahuiste (*Nolina texana* Wats.) and the Spanish dagger (*Yucca baccata* Torr.) being dominant in such areas. The leafless buckthorn (*Adolphia infesta* Meisn.) is prevalent on many of the south and west facing slopes and shoulders of some of these bare ridges.

West of Mount Livermore and separated from it by a pass about one-fourth mile wide is a high ridge extending in a general east-west direction. The vegetation on this ridge is quite like that of the north and south slopes of the peak itself. At the foot of the north slope of this ridge, however, is H O Canyon, whose source is not on the mountain but on a pass separating the canyon from the west branch of Madera Canyon. The north slope of this western ridge furnishes most of the drainage into the upper reaches of H O Canyon, several tributaries from the ridge uniting with the canyon within the two miles of its western extent to the foot of Sawtooth Mountain. In a well watered spot in the bed of H O Canyon about a mile down from its origin there are several large walnut trees (*Juglans major* (Torr.) Heller). Some of the specimens are more than a foot in diameter and almost fifty feet high.

Summary

The Davis Mountains are a lava region resulting from deformational movements of late Cretaceous time, later lava flows, and consequent severe erosion. Mount Livermore, the highest point in the group, probably marks the line of a fissure eruption.

Early botanical work on the area was done by collectors and descriptive writers; investigations since 1900 have dealt mostly with the ecological phases of botany.

Comparison of the records of Fort Davis and McDonald Observatory on Mount Locke indicates an average annual precipitation of at least twenty-five inches on Mount Livermore.

The vegetation of the north slope of Mount Livermore is a part of the Petran montane forest. Most of the area belongs to the oak woodland or to various combinations of *Pinus-Juniperus-Quercus* groupings. Some of the canyons have their own characteristic vegetation.

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